LaSrFeNi-oxide: a promising cathode material matching proton conductor specifications for intermediate temperature solid oxide fuel cells

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Solid oxide fuel cells (SOFCs), which convert chemical energy directly into electricity by using H_2 or CO gases of a reformed hydrocarbon as fuel are promising power generation devices for more efficient and cleaner energy [1]. They are expected to achieve, for electrical power generation in the 1 kW to 10 MW range, net electrical efficiencies up to 65%. They typically oper-ate at temperatures as high as 800°C, which poses a lot of stress on the infrastructure of fuel cell. Therefore, there is a need for materials that allow SOFC to operate at lower, intermediate temperatures such as 500°C. We identify LaSrFeNi-oxide as a potential cathode material for SOFC, be-cause it has its maximum conductivity in the same temperature range. Together with ceramic proton conductors, the realization of an intermediate temperature SOFC seems to become feasible.

Extensive characterization of the cathode is needed to redouble the efficiency of the SOFCs. Our multinational consortium attempts here an exhaustive experimental characterization of the crys-tallographic and electronic structure of a complete matrix of LaSrFeNi-oxides, including its end members $LaFeO_3$, $SrFeO_3$, $LaNiO_3$, and $SrNiO_3$, including sintered ceramic bars and very thin single crystal films.

The crystallographic structure is determined with conventional x-ray diffraction, supple-mented by high temperature x-ray diffraction and dilatometry to monitor phase transitions (rhom-bohedral-cubic) as a function of temperature and relative Sr content. Core level soft x-ray absorp-tion spectroscopy at the oxygen K shell and Fe/Ni L shell absorption edges allow us to monitor hybridization effects between the 3d metals and oxygen, to determine the potentially transport relevant spin states, and to correlate this information with the electric conductivity.

The Fe 2p spectra of the compounds for low Sr concentration remain essentially unchanged, but for higher Sr content a second component appears in the spectra. Conductivity measurements suggest a transition from semiconducting behavior to metallic as the temperature increases and this transition temperature strongly depends on the Sr content.

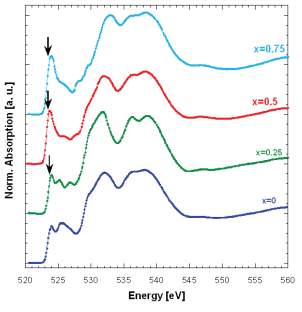

Figure 1: Oxygen K edge x-ray absorption spectra of $La_{1-x}Sr_xFe_{1-y}Ni_yO_3$

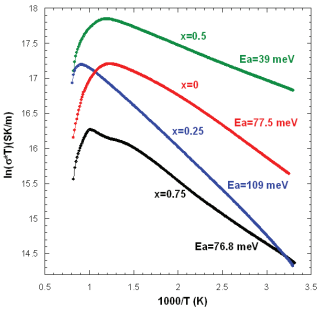

Figure 2: Temperature dependent electric conductivity of $La_{1-x}Sr_xFe_{1-y}Ni_yO_3$

Reference

[1] J. B. Goodenough and Y. H. Huang, Journal of Power Sources, 173 (2007) 1–10.

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